AMENDMENTS TO THE SPECIFICATION

In the specification of the Application, please amend paragraphs 0001-0027 as hereinafter indicated.

MICRO FILTER DEVICE FOR AN IN-LINE FILTERING CONFIGURATION

Technical Field

[0001] The present invention generally relates to an oil filtering device. ~~In particular, it concerns~~ The present invention more particularly relates to an oil filtering device having micro-filtration capability, with [[the]] a filter being contained in a housing having both an inlet port and an outlet port. Oil travels through the inlet [[part]] port, is radially flow filtered by the filter, and exits the outlet [[part]] port.

Background

[0002] [[Such]] Oil filtering devices are generally known and commonly are provided with a filter part for filtering particles from oil that has contacted rotational parts, such as in transmissions, and ~~which~~ that even may have been used for lubricating engines. Nowadays, with increased engine power, the increased use of automatic transmissions with torque converters, and [[with]] the increasing refinement in valve components within such hydraulic systems, it has become ~~a desire to have refined~~ desirable to refine the filtration of [[the]] oil to a considerably increased ~~amount~~[[,]] degree [[i.e.]] by ~~so-called~~ so-called micro filtration. Such ~~desire~~ desirability also emanates from [[a]] public convenience and the desire [[of]] for not ~~needing~~ having to change the oil in cars, at least ~~to have such need to a much lesser extent~~ not as frequently.

[0003] Micro filtration as such, and its effect as compared to conventional filtering, is [[know]] generally known ~~per se~~[[,]]. See, for example, ~~e.g. from~~ SAE paper 2001-01-0867, which is entitled "Automatic transmission hydraulic system cleanliness - the effects of operating conditions, measurement techniques and high efficiency filters[[",]]," and which ~~document~~ is ~~hereby~~ incorporated herein by reference. Micro filters per se are also ~~know~~[[,]] generally known. See, for example, ~~e.g. from~~ international patent application PCT/NL00/00530, which is also incorporated herein by reference ~~herein~~. The known micro filter consists of radially wound more or less relatively highly compressed cellulose fibers. This type of micro filter is suitable for and known from application in a ~~so-called~~ so-called by-pass configuration. In such a configuration, the original filter of the hydraulic system remains in its original position in the flow system, i.e. remains in a ~~so-called~~ so-called in-line arrangement, while independent from the main hydraulic stream, an auxiliary hydraulic loop is created, in which the micro filter is incorporated. The auxiliary loop may, [[e.g.]] for example, consist of only a minor part of the entire hydraulic flow, [[e.g.]] for example, 10%. Yet, in this manner, over time this configuration effects a gradual decrease of degree of contamination of the oil up to the level of the filtering grade of the micro filter. With a micro filter as known, a "fill for life" for passenger vehicles may be accomplished, especially since a large amount of filtered particles may be accommodated in the filter due to a relatively extremely large radial thickness of the filter material on the one hand, and on the other hand because a low degree of contamination of oil tends to slow down further contamination thereof. The requirement for an additional hydraulic flow and an additional filter device, thus for increased initial costs, has in automotive applications up to now hampered ~~wide spread~~ widespread adoption of the micro filter, despite its advantages.

Summary Of The Invention

[0004] It is therefore an object of the present invention to provide a solution enabling the use of a micro filter in an in-line configuration[[,]] ~~be it~~ with ~~lowest~~ a low amount of complexity, ~~with lowest~~ a low amount of initial ~~costs~~ cost, [[or]] and/or with optimized functionality of the micro filter. According to one embodiment of the invention, such has been realized with the filtering device for an in-line configuration being provided with axial end faces which are formed from the micro filter. The device includes an internal flattened filter end face contacting face for axially closing a passage of oil. The contacting faces have a diameter substantially equal to that of the filter part. by-pass mechanism formed by an aperture provided in a closing member for closing off an axial end face of the micro filter. The device includes a closing face integrated into an insert member accommodating irregularities in shape of the housing at an axial side of the insert member opposing the closing face. The insert member is associated with an O-ring corresponding to the largest diameter of the insert member.

[0005] With a device according to the foregoing embodiment, a micro filter may effectively be incorporated in an existing housing for an in-line arrangement, guaranteeing a sufficient flow by a micro filter through reduced resistance of a relatively thin radial thickness, yet of a sufficiently large body thickness to realize [[a]] micro filtration at a relatively long oil changing time interval, at a filtration degree that has at least shifted ~~towards~~ toward the least fine end of an interval of typical micro filtration. With the device being provided with internal, essentially flattened filter end face contacting faces for axially closing a passage of oil, having a diameter matching that of the filter part, it has become suited for direct and correct application of the micro filter parts of the kind preferred by the invention, while still a sufficient amount of filter material is included in the device.

[0006] In accordance with an embodiment according to the invention, the closing face is integrated in an insert member fitting irregularities in shape of a relevant part of the housing

at an axial side of the insert opposing the closing face, and being provided with an O-ring preferably corresponding to the largest diameter of the insert member. In such an elaboration of the invention, however, an aim of the invention is achieved with lowest possible effort at both end user and manufacturer, since such measure enables the use of a micro filter by simple replacement of a conventional filter [[by]] with a micro filter.

[0007] In accordance with another embodiment of the invention, with an oil passage closing face integrated in a housing part, an overall economic and functionally improved device is achieved. In this respect, if an oil passage closing face is integrated in a housing wall part having a thickness of more than twice the thickness of the majority of the wall part of a relevant unit of the housing, an initially ~~cost effective~~ cost-effective and relatively ~~easily to implement~~ easy-to-implement solution is provided, in that only a tooling part for shaping the interior of a housing part needs to be adapted by taking away material from it.

[0008] In a further aspect of the invention, micro filters of a relatively very fine filtering grade, as well with a relatively high filtering efficiency, may be applied by using a device ~~which~~ that is at least at one end provided with a separate oil flow closing member contacting an end face of the filter part at one axial end and contacting a housing part via a ~~spring loaded~~ spring-loaded mechanism. The use of such arrangement enables the passage of oil between the end faces of filter and closing member at oil pressures higher than the spring pressure, thus creating the possibility of a by-pass functionality of oil, so that within a structure for an inline filtering arrangement, a by-pass functionality is created, realizing a sufficient oil flow at a relatively advanced level of micro filtration, which has become possible through the by-pass functionality. Thus, in accordance with an aspect of the invention, an improved filter device is realized in that the filtering device is provided with a by-pass mechanism, such that during operation of any system in which the device is incorporated, a minimum flow of oil through the filter device is secured by [[said]] the by-pass mechanism.

[0009] In one advanced version of such a by-pass mechanism including a filter device, the by-pass mechanism is formed by an aperture such as a bore, provided in a closing member connecting the space in the filter device exterior to the filter part to an interior space of said filter part for receiving oil radial passed through the filter and for receiving any oil passed through said aperture. In this way, the by-pass flow may be better controlled, while leaving the closure of the axial end faces ~~in tact~~ intact at all time, which is of advantage because any debris gathered here tends to loosen relatively easily, so that part of the filtered material would otherwise, be it with the security of return into the filter over time, ~~re-entered~~ re-entered into the oil flow. This solution secures a base flow of oil, while at increasing operating pressures, a relatively larger part of the flow passes through the micro filter.

[0010] In yet another embodiment of the filter device according to the invention, the by-pass mechanism comprises a pressure dependent valve situated in, or connecting to [[said]] the aperture, [[said]] the valve at low oil pressures being in a closed mode, while changing to an increasing opened position in relation to an increasing actual oil pressure. Preferably this way of arranging a by-pass according to the invention, is realized with an elastically deformable device, having an internal passage opening up at increasing oil pressure against an internal pressure of the valve material, in particular resisting said elastically deformation with increased force at increased amount of deformation. With such manner of by-pass arrangement, a flow of oil is guaranteed in a previously describe controlled manner at relatively high operating pressures.

Brief Description Of The Drawings

[0011] The present invention will now be elucidated further along ~~a drawing~~ by drawings in which:

[0012] Figure 1 schematically represents a filter device that is integrated with an oil cooler device;

[0013] Figure 2 represents a cross section of a first modification of a filter device according to the invention, allowing the replacement of a conventional filter part by an e.g. cellulose fiber based, ultra fine grade filter, i.e. within the existing housing of [[said]] the conventional filter, enabling both after sales replacement and factory based replacement;

[0014] ~~Figure~~ Figures 3 and 4 relate to a filter device with a cost-optimized factory modification of the interior of a conventional filter housing, enabling the manufacturers application of an ultra fine filter part;

[0015] ~~Figure~~ Figures 5 and 6 relate to a filter device with a functionally ~~optimised~~ optimized modification of the interior of a conventional filter housing, enabling the manufacturers application of an ultra fine filter part;

Detailed Description Of The ~~Drawings~~ Invention

[0016] In ~~the figures~~ figures 1 through 6, identical reference numbers generally relate to identical or at least comparable technical features.

[0017] Figure 1 schematically represents a filtering device 1, applied in combination with an oil cooling device 2. The device 1 is provided with a housing 3, opened at one side that is pressingly attached, here by bolts 10, to [[a]] the cooler device 2. It may either be connected directly to the housing of the cooler 2, or indirectly via a base plate not depicted, to which both devices are [[than]] then attached. The filter device 1 is fed via an inlet port connected via a bore 4 to an outlet port of the cooler device 2. The cooler 2 receives heated oil, e.g. by an engine or a transmission, via an inlet port 6. The oil is cooled while being fed through the cooler device 2, which is in turn cooled by

a preferably liquid cooling agent, running through a separate channel system, having an inlet port 7 and an outlet port 8. The cooled oil received by the filter device 1 is radially forced through the cylindrically shaped filter part 5 of which one axial end is closed, while the other end connects to a discharge port 9 of the filter device 1. The device 1 is provided with tightening mechanisms in the form of bolts 10, which has the advantage that a filter part 5 within the housing 3 may be clamped against the lid 17 without the latter being possibly affected by any rotational movement. However, the lid 17 may in principle also e.g. be connected to the house 3 by a threaded provision for a mutually screwed connection.

[0018] Figure 2 in more detail depicts a cross section of the filter device 1 of figure 1, however fitted with an ultra high efficiency filter 20 for micro filtration within a generally known housing 16 as suited for a conventional, e.g. in-line filter, typically allowing a high throughput of oil and capable of filtering particles of e.g. 20 µm and larger. Micro-filtration typically is capable of filtering particles of 0.5 µm and larger. Rather than at conventional filters, which only, or at least mainly are based on a sieving principle, this result is possible since micro filtration is based both on sieving and on a polarity or binding principle where contaminations are bound to fibers. In certain cases, the filter 20 applied is capable of filtering particles of 0.5 µm and up. One type of micro filter that may be used for the present purpose is a cellulose based filter. The housing 16 for such conventional filter part 20 shows an outlet port 9 accommodated in a tube shape, integrally shaped with a thickened support part 11 of the relevant wall part 13 of the housing 16, in this case, the wall part 13 is oriented axially in relation to the cylindrical filter part 20. In conventional application, this support part 11 functions as a support for [[bath]] an O-ring 15 fitting the transition from the support base to the tube part [[10]] 9. In such conventional application, the O-ring 15 in turn supports the relevant axial end of the filter part 20. The inlet port, associated with a bore or tube 4 not depicted in this figure, is provided in a locally widened housing part 3A of the filter device 1. The bore or tube 4 may be provided either in the lid part 17 of the housing 3 or in the main housing part 16.

[0019] In the embodiment according to figure 2, the use of a micro filter 20 within the structure adapted for receipt of conventional, in-line oil filters is enabled by the provision of a rigidly formed filler part 14 and [[a]] the large diameter O-ring 15 fitting into the space between the thickened wall part 11 and [[a]] the radial housing part 16, filling the space between the axial wall part 13. The filler part 14 simultaneously forms an axial end closure to the micro filter part 20. An axial end wall 20F of the filter part 20 stretches in a plane oriented transversely to the axial direction of the filter part 20. The filter part 20 is formed with a filter of which the radial thickness is substantially larger than the radius of the cylindrical inner space 21 of the filter part 20. The central space 21 is formed by a perforated tube part 22 forming an internal wall of the filter part 20. The other axial end 20F of the filter part 20 is also closed for oil passage by ~~an other~~ another end closure member 24, also rigidly shaped and also provided separate from the filter part 20. The closure members 14, 24 are pressed against the relevant end faces 20F of the filter part 20 under the influence of a rigid connection between the filter housing 16 and relevant wall part 17 associated with the cooler device 2, and of a close tolerance fitting of the relevant parts, thereby relying on a fractional axial deformation capacity of such cellulose material based filter part 20. An advantage of the current filtering arrangement is that the housing 16 may entirely remain unchanged. This, in turn, enables both the after market application of a [[micro]] filter [[20]] 1 and an easy to implement factory mounting of a micro filter 20.

[0020] Also, for accommodating less strict tolerances, thereby reducing manufacturing costs, a spring member 25 may be provided between the wall part 17 and the closure member 24. For the purposes of enhancing proper positioning of the filter part 20, a dimple 26 may provided in the wall part 17, receiving part of the closure element 24 and preferably the spring device 25. In the depicted ~~sophisticated~~ embodiment of this feature, the closure element 24 is provided with a small, axially exterior part that is of radially smaller width, such that the spring element 25 may be received and straight guided by the thus created opening or groove between the dimple 26 and [[said]] the closure part 24. Preferably the spring 25 is of a diameter at least almost corresponding to the outer

diameter of the closure element 24, which in turn, the other closure member 14, has a diameter corresponding to that of the filter part 20. In this manner, a relatively thick and highly loadable spring 25 may be accommodated. The arrangement with [[said]] the dimple 26 provision also positively influences the axial length of the filter part 20. Both closure elements 14, 24 are preferably provided with a generally cylindrical notch 27 fitting the internal space [[23]] 21 of the filter device 20. The notch 27 of the closure member 14 connecting to the outlet port 9 is provided with a central bore for oil discharge. Especially in case the device 1 is provided with a spring 25, the closure members 14[[,]] and 24 and [[the]] their respective radial contacting faces [[16AF]] 14F and [[16B]] 24F, as also alternatively described [[at]] in the following figures, are preferably provided with concentric ribs ~~which~~ that are pressed into the material of the end [[face]] faces 20F of the filter part 20.

[0021] In accordance with a further aspect of the invention, the filtering device 1 is fitted with a spring member 25, while the relevant[[,]] ~~outlet 9 opposing~~ outlet-opposing closure member 24 may also be provided with a bore 28, either fully open or fitted with a pressure dependent valve member as known and not depicted in the figure. The filter device 1, when thus provided with a bore 28 only, is adapted as a by-pass filter system, securing a base flow of oil that is directed through the bore 28. At relatively high pressures, when the oil flow may not fully pass through the bore 28, it passes radially through the filter part 20. In this manner, the filter device 1 functions as a by-pass filtering system at relatively high pressures only. Yet, in practice, if at least a part of the oil passes through the micro filter 20, the oil will in time gradually become entirely filtered, i.e. will become cleaner up to the level determined by the chosen filtering grade. The diameter of the bore 28 may be varied in accordance with the desired base flow and the desired percentage of oil passing through the filter part 20 per unit of time, taking into account the chosen specifications of the filter part 20.

[0022] The filter device 1 according to this further aspect of the invention may also be provided with a valve member [[28]] fitted to the ~~above mentioned~~ above-mentioned bore

28. In this manner, a filter device 1 is created for securing an additional oil passage in addition to the oil passage through the filter part 20, given a certain pressure at which the oil is provided to the filter part 20. The valve member accommodated according to the invention opens wider with increasing pressure. Such a pressure dependent valve member enhances certain applications or certain operating conditions where a micro filter 20 may not allow for a sufficient flow as often required by so called in-line filter applications. The filter device 1 according to the invention then operates as a by-pass filter, accommodated in a typical in-line filtering arrangement. Typically, such a valve member known per se is composed of an elastically deformable synthetic material, having a tube part with an inner cylindrical opening at one end, gradually changing into a rectangular like, and subsequently line like opening at the other end, which without internal oil pressure acting on it is closed by internal wall parts being pushed against each other. This end part of the tube may open under oil pressure under a resistance force acting against elastic deformation emanating from the combination of the particular shape and the elastically deformable nature of the material. Therefore, depending on the desired guaranteed flow rate at any pressure level, and depending on the specifications of the filter 20[[,]] such as radial thickness, axial length, and filtering grade, the valve member may be designed in accordance with a ~~manufacturers~~ manufacturer's desire.

[0023] Figure 3 depicts an elaborated embodiment 16A of a conventional housing 16 for accommodating a micro filter device 20A. The embodiment incorporates the advantage of reduced material cost at a minimum adaptation of a manufacturing tool vis a vis a relatively high functionality of the filter part [[20]] 20A. The improved functionality of the current device is in particular related to an increased effective axial length of the filter part 20A within the prescribed outside boundaries of the housing 16A. The radial housing part 16A acts as an oil passage closing face 16AF. The oil passage closing face 16AF can be integrated in a housing wall part 13 having a thickness of more than twice the thickness of the majority of the corresponding radial portion 16A of the housing 16, 17. By a measure

incorporating a relatively easy to perform removal of material from a tool for shaping the interior of the housing 16A, the lower side of the housing 16A is formed at least virtually flat, such that it may function as a closure member 14 to the relevant axial end face [[17F]] 20AF of the filter part [[20AF]] 20A. This embodiment is preferably combined with the creation of an e.g. ~~ring-like~~ ring-like dimple 26 in the cooler housing associated plate 17, such that the dimple 26 functions both as a closure member to the filter part [[20]] 20A and as a positioning provision. Apart from the advantage of elongating the filter part [[20]] 20A, no further parts such as O-rings 15 or separate closure members 14 or 24 are required, thereby reducing manufacturing effort and costs.

[0024] Figure 4 represents an embodiment in accordance with the main measures taken in the design of figure 3, however now provided with one separate closure member 24, which is provided at the upper side of the filter part 20A. At the expense of a slightly lower axial length of the filter part 20A, the functional possibilities of the use of an open bore 28 in [[said]] the member 24 or of the application of a valve member are introduced, both as explained along the embodiment of figure 2. Still, however, no O-ring 15 and only one closure member 24 is needed ~~at using~~ when implementing this feature of the invention.

[0025] In figures 5 and 6, an in view of the designs of figures 3 and 4 respectively further elaborated version of the filter device 1 according to the invention is depicted. It requires a new, i.e. enlarged shaping tool for the interior of the filter housing 16. However, the advantage of such, in comparison to the previous[[,]] relatively costly measure, is an optimized use of axial length of the micro filter 20, which is advantageous because it effects an increased oil throughput [[of]] in the device 1, and which is generally important [[at]] in an in-line filtering arrangement.

[0026] The invention, apart from the following claims, also relates to the preceding description and all details and aspects in the ~~drawing~~ drawings, which are directly and unambiguously derivable ~~there from~~ therefrom, at least by a [[man]] person skilled in the art.

Abstract

[0027] An oil filtering device for an in-line filtering configuration. The device has a filter part having a micro-filtration device for filtering oil, wherein axial end faces of the filtering part are formed by the micro-filtration device. The device includes a filter housing having a lid, an inlet port situated outside the filter part for radial flow-filtering of the oil, and an outlet port in fluid communication with a cylindrical interior space of the filter part. The device also includes a by-pass mechanism formed by an aperture provided in a closing member which sealingly engages an axial end face of the filter part, the aperture connecting the interior space in the filter part to a space exterior to [[said]] the filter part. The by-pass includes a valve mechanism movable between a closed position at a lowest operating oil pressure to an open position as a function of increasing operating oil pressure.